AGRICULTURE RECONSTRUCTION AND DEVELOPMENT PROGRAM FOR IRAQ

STRATEGY FOR WATER AND LAND RESOURCES IN IRAQ
Phase 1 Project Completion Report
Annex 1 - Review of Phase 1 Data Sets

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STRATEGY FOR WATER AND LAND RESOURCES IN IRAQ
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Preface

This Annex contains an incomplete data review reflecting the status of the preparation of the Phase 1 Completion Report at mid August 2006 when the project was put on hold.

The status of hydrometric data for the rivers of Iraq and operational data for the major hydraulic control structures is the subject of a separate annex: Annex 17.

1 Introduction

1.1 Structure of this Annex

Data collection and review has been one of the major activities in Phase 1. The present Annex briefly recapitulates the approach to this important activity and then describes the status of data collection, identifies outstanding data, and discusses the quality of the information received.

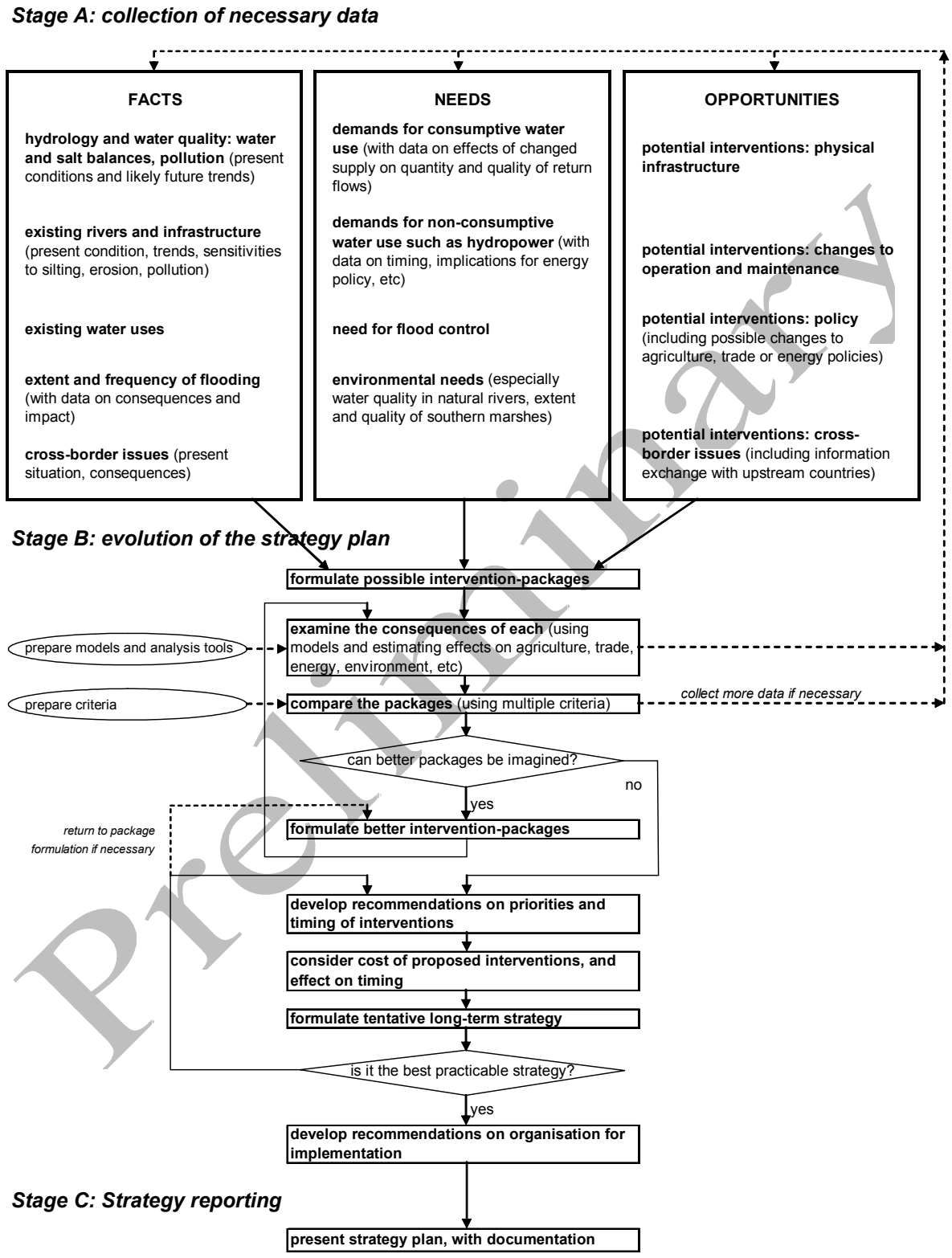
Figure 1.1 shows the overall planning approach adopted for the SWLRI project to emphasise the initial data collection, and to highlight that the development and testing of models and analytical tools and the comparison of alternative interventions were both expected to lead to further information needs.

Table 1.1 provides some guidance on where to find material in this Annex. It should be noted that further data assessment is reported in Annex 17.

Table 1.1: Where to Find Information in this Annex

Subject	Location
Data requested from the ministries	Sections 1.2 and Appendix A, Sections 4 - 9
Data repository on Claromentis	Section 2.1
Quality control procedures	Section 2.2
Meteorological data	Section 3.2.2
River Flow data	Section 3.2.3 and ANNEX 17
Water flow in canals and drains	Section 3 and Section 4.3
Major hydraulic infrastructure	Section 3.2 and ANNEX 17
Agricultural information including water use	Section 4
Groundwater information	Section 5
Population	Section 3.2.4
Environmental information	Section 3.2.5
Water supply and sanitation information	Section 6
Water quality and pollution information	Section 8
Hydropower information	Section 7
Opportunities (potential projects)	Section 9
Recommendations	Section 10

Figure 1.1: SWLRI Planning Approach



1.2 Identifying What Data is Needed for Planning Studies

There are several types of information that need to be compiled to provide the basis for strategic planning of water and land resources:

1. **Inventories** which list and map the location of physical infrastructure (dams, boreholes, canals, drains, pumping stations etc), and monitoring points. The inventories should be 'live' and reflect the number and status of facilities in the country as they are now, and in some cases as they were in the past.

2. **Time series records** of river, canal and drain flows, water quality, population details, agricultural production statistics etc. These should be regularly updated at a frequency to suit the type of data.

3. **Areal features** of the natural environment and anthropogenic activities (soil type, forestry, land classification, population distribution, cropping patterns, urban areas, seasonal flooding, salinisation, etc). When linked to remote sensing and to GIS areal information can be obtained and presented in many ways that contribute to the strategic planning process.

4. The **planning framework**. Details of national aspirations as expressed in government policies and legislation that provide the context for strategic planning for the water and agriculture sectors. Included in this are the policies and plans for other sectors (energy, health, trade etc) that are linked directly or indirectly to the water and agriculture sectors. The water sector cannot be considered in isolation and up to date information on the activities in other sectors will be needed.

5. **External pressures**: economic status and relations, migration, international relations, climate change, international commodity prices, etc.

The following sections discuss the requirements in relation to the three data sets referred to in Figure 1.1: facts, needs, and opportunities.

1.2.1 The 'Facts' Data Sets

All the data types and examples listed above are associated with the 'facts' data. The General Scheme reports provided guidance as to what should be collected in order to support the planning process. The consultants prepared a preliminary list of the required data to describe the baseline situation in terms of natural and man made elements. This list is reproduced in Appendix A. In addition ministries were asked to update various tables from the General Scheme – this particularly applied to agricultural data. Throughout the need for geo-referenced data was emphasised so that the maximum use could be made of GIS and mapping tools.

1.2.2 Data on Needs

Needs data is more likely to be synthesised than measured so that compilation of this data set is more a matter of analysis of other data than the collection of actual records.

Consumptive water uses (for agriculture, industry, or potable water) are not generally monitored with sufficient frequency or accuracy to make the data very practical for planning studies. In particular, records where available are usually for bulk abstraction and can be very difficult or impossible to disaggregate. Therefore the needs data is typically built up using standard procedures and aggregated to give the estimated bulk demand. This process calls for other data from the 'facts' category. For example in order to estimate irrigation water requirements for a whole scheme it is necessary to know what crops are being or are to be grown and over what area, the planting and harvesting dates, design meteorological conditions, land preparation requirements, and irrigation efficiency allowances etc. If the estimate is for a future planning horizon then the cropping pattern, the land preparation requirements and the irrigation efficiency could all be different depending on government policies, and projected changes in the socio-economic situation.

1.2.3 Information on Opportunities

Opportunities represent possible actions or interventions for MoWR and other ministries to budget and programme for, and to implement in the short, medium or long term horizons. They represent potential calls on the national budget in the near and longer term and as such need to be prioritised for the water and agriculture sectors as a whole. Opportunities cover an exceedingly wide range of possibilities from new studies to actual construction, from policy change to capacity building and training, etc.

It has been agreed to use a main planning horizon of 30 years, with greater detail for the next 5 years and some strategic consideration of the longer outlook beyond 30 years. The planning process is designed to be periodically updated in a rolling manner, for instance every 3 to 5 years.

1.3 Data Collection

1.3.1 Approach

The Phase 1 Scope of Work described the intended approach to the data collection activity:

'The consultants will rely on the Iraqi ministries and other institutions for nearly all data collection work. Much of the necessary data is already available on paper or in electronic form, and the institutions will need to make staff time available to find it, collect it, collate it in convenient form, and transmit it to the team members abroad. Counterpart staff assigned to this work will need not only time but also the necessary authority to obtain data from people and offices that keep it; they will thus need strong support from senior levels in the ministries.'

'Information will be entered into electronic files of appropriate format by the data collectors wherever possible, and where this is not practicable it will be sent on paper to the analysts for entry into data files.'

The data collection exercise started with a long list of typical data required for strategic planning and a large number of data proforma developed by the consultants. Each ministry was provided with a copy of the General Scheme Stage 2 report on CD so that they could see what data had been presented and how it had been used in the development of the strategy that was described in the report. It was made clear during discussions with ministry staff that the SWLRI project was initially seeking the same type of data as had been collated and presented in the General Scheme Stage 2 report in order to undertake a similar strategy development study. The feedback loop where the exercise of developing and testing models and analytical tools identifies new data requirements to be met (see Figure 1.1) was also emphasised from the start.

Monthly data collection meetings were held to provide an update on progress. In September 2005 each ministry nominated a Data Collection Leader who was given the responsibility for providing the link point between his ministry and the consultants team.

1.3.2 Claromentis

At an early stage in the project it was decided that a web-based collaboration system was essential to the proposed data collection activities, and would be a tool for helping to build strong links between the stakeholders and to provide opportunities for other ministries to benefit from the project's activities.

Claromentis, was selected to act as the project data repository and email system. To encourage participation and eventual data sharing Claromentis has been designed to give each ministry a secure extranet area which has been customised for them. In this area set aside for them each ministry is able to manage its own data.

At the end of Phase 1 there were over 13,000 items loaded onto the system (September 2006), the majority of which are items of data. The following table shows document quantity based on application type:

Table 1.2:Status of Documents of Claromentis (end September 2006)

Application type	Documents Quantity
Unknown Document Format	513
RAR-compressed Archive	2
ZIP-compressed Archive	193
Microsoft Word Document	505
Microsoft Excel Document	2652
HTML (HyperText Markup Language)	55
CompuServe Bitmap Image	1
JPEG Image	9570
Text Document	11
Adobe PDF (Portable Document Format)	206

At the end of Phase 1 ARDI handed over the role of Claromentis Administrator to an IT specialist from MoWR and the hardware was transferred to Baghdad.

2 Data Compilation and Checking

2.1 The Data Repository

Most of the items submitted by the ministries to the SWLRI team were hard copy that subsequently had to be scanned, hence the preponderance of JPEG images in the Claromentis data repository (Table 1.2). The Phase 1 Scope of Work had envisaged that a much higher proportion of the data would be provided in digital format such as Microsoft Excel spreadsheets, tables in Microsoft Word or text files. As a consequence the ARDI team to support the data collection exercise was both expanded and kept in place for considerably longer than originally anticipated to cope with the workload of scanning and uploading images. The scanned image format, while useful for storing information, does not allow the data to be analysed directly.

Given the security problems that have affected the country the simple fact of creating an electronic record of such a large body of original paper data records is a very valuable precaution to safeguard the data. Therefore the ARDI team have scanned all material handed over to them by the ministries even when in some cases the material may not have been of immediate relevance to the SWLRI Unit.

The scanned data sheets have been uploaded to Claromentis either by the relevant ministry or by the ARDI team. The data has been reviewed remotely by other members of the ARDI team and comments, questions and further data requests have been passed back to the ministry Data Collection Leaders via email, occasional telephone conversations, and more importantly through the regular data collection meetings.

Many of the queries back to the ministries related to the lack of geo-reference information. In many cases it is necessary to know the location of sites where data has been recorded. This has generally been given as a description and grid references are required to make more effective use of this information.

Data was also requested and received from other project teams. Such data has not been subject to any further checking.

2.2 Generic Quality Control Procedures

The nature and extent of the quality control checking depends on the technical field. It was recognised that in the time frame of Phase 1 it would not be possible to complete full quality control on all the many data types required for strategic planning. However, procedures should be put in place to ensure that routine QC was established and standards were as high as possible.

In all cases the data must be finally signed off as ‘acceptable’ before it can be accepted as part of the strategy database. MoWR must have the final say in this as the principal end users. A staged approach to acceptance was proposed and was discussed at the January 2006 Steering Committee meeting. Some of the concepts, familiar to those with experience of working within Quality Assurance systems, such as keeping an ‘audit trail’ with individuals signing off their work were the subject of considerable debate. The conclusion was that introducing QA procedures identifying individuals would have to be a gradual process.

In reality it is highly desirable that QC of data should be undertaken by the ministry that is providing the data to the SWLRI Unit. For example, the Ministry of Municipalities and Public Works has experienced engineers who can, and should, review the data on water treatment works capacity and performance, and decide upon appropriate design criteria for consumption for different types of consumer. The SWLRI Unit does not have staff with the same experience and therefore should not be attempting to QC data without discussions with the data provider.

With this in mind a generic staged QC process is described below that can be adapted to suit the particular characteristics of the data under examination. For example, the QC procedures for hydrometric data (meteorological, river level and flow, groundwater level) are well established with specialised software to aid the process (HEC's DSS software) and so will differ from the QC procedures appropriate to checking agricultural crop statistics. The use of DSS, and the QC exercise on the hydrometric data that was used to develop the Tigris-Euphrates ResSim model, are fully described in Annex 17.

The generic QC process is outlined in Figure 2.1.

Figure 2.1: Generic Quality Control Process

Receipt of Incoming information
Who from?
What format is it in (spreadsheet, word, GIS layer, JPEG etc)?
Where is it stored on Claromentis?
If hard copy, where is it stored, and when does it have to be returned by?
Does it need scanning? All pages? If not all, identify which to be scanned.

NON-TECHNICAL CHECKING – Level 1
After scanning
Check all original pages have been scanned and are legible
Where is the scanned version stored on Claromentis? – this is now the original, 'raw' data

Conversion to digital format (by Optical Character Reader or typing in)
Check that the data entered matches the original
Where is the digital file stored on Claromentis? – if this matches the scanned version exactly it is also the original 'raw' data

TECHNICAL DATA CHECKING/REVIEW – Level 2
Initial review to identify suspicious data – *record suspicions in note form*

- Do the daily values sum to give the monthly value?
- Do the monthly values sum to give the annual value?
- Are units of measurement clear and any conversion factors correct?
- Plot graphs (if appropriate)
- Compare to previous years for same data
- Compare to any equivalent data received from another ministry or seen in a technical reference or report
- Pass the data and all checking records *plus your notes* to a senior officer for review

Senior review to advise on additional checks, or to correct any mistakes made in the checking process.
If suspicions remain: contact the originating ministry data collection leader, or directly to the department responsible for the data if known
Request them to QC the data set themselves (they should have internal procedures for QC and they also have the specialists for that particular data type who can give an expert opinion on the reliability of the data) – *check the digital file 'out' on Claromentis*
If they withdraw the data and reissue a corrected data set – *upload revised data file and Claromentis will record the version change. Add a note to the old file version to say why superseded*
If they confirm the data as reliable – SWLRI Unit must make a judgement
If they are unwilling to assist – SWLRI Unit must make a judgement

SWLRI UNIT ACTION
How important is this particular data set?
If needed for current work to progress – SWLRI Unit must adjust or revise the data
If not essential – *check the file back in on Claromentis unchanged and alter the meta field to record that the information is still under suspicion*

ADJUSTING OR REVISING THE DATA – Level 3
If the data is of a very specialised nature the SWLRI Unit should seek expert advice (within the MoWR, local experts, or consultants)
Otherwise the senior staff member will need to use their skill/experience to adjust or revise the data – *recording what changes were made and why*
Check the revised file onto Claromentis so that a new version is created and add a to the note field the reason for the changes and who made them and when.

3 Data Assessments

3.1 Introduction

The assessments described here review the collected data only in terms of their suitability for the needs of the SWLRI Unit for its planning activities. The descriptions are by field rather than by ministry because a number of data types are collected by more than just one ministry – water quality data is an example being collected by at least three ministries. Where the data is highly relevant to the development of the Tigris-Euphrates Water Management System Model the detailed review is presented in Annex 17.

Geo-referenced data was sought at the outset because of the ease with which erroneous data can be identified once it is plotted especially if plotted against a satellite image or topographic map background. It was apparent at an early stage that geo-reference (grid reference) information was rarely available and that there was a reluctance to share any available GIS information. The GIS strategy, discussed in Section 4.3 of the Main Report, took a different approach by providing training and other support to the GIS capabilities of individual ministries to geo-reference their own data and to be responsible for the quality control process.

3.2 Topic Areas Subject to Limited Review

These have been subject to only limited review for the following reasons:

- Fully described in Annex 17
- Data received from another project and therefore deemed to have already been reviewed
- Little data received to review

3.2.1 Water Control Infrastructure

Information describing the major water control infrastructure has been collated and checked by HEC and the MoWR in the course of developing the Tigris-Euphrates ResSim model (see Annex 17).

Information on the status of irrigation schemes is however incomplete. For example, no GIS layers of irrigation schemes and their associated control structures and pumping stations were available and the ARDI consultants have started the task of developing these essential maps for the MoWR GIS Section to complete – this will depend on obtaining geo-references for most of the structures. During the Study Visit in June 2006 the MoWR visitors attempted to improve upon the scheme status data sets and progress was made. This is an area where the SWLRI Unit need to press for complete data.

3.2.2 Meteorological Information

Most of the meteorological information obtained during Phase 1 was transferred from another ARDI component the AEZ (agro-ecological zones) pilot project with the Ministry of Agriculture. The data was not separately reviewed for SWLRI because it had already been assessed and accepted for use by the AEZ project.

3.2.3 River Flow and Reservoir Operation Data

HEC have carried out a comprehensive assessment of the available data in collaboration with staff of MoWR. This is reported in detail in Annex 17. Their assessment covered all the data types required to build and test the Tigris-Euphrates WMSM, but only for locations relevant to this model or the pilot ResPRM model of the Diyala basin.

3.2.4 Population Statistics

These were obtained as expected from several sources, many of which were consultants' reports. The SWLRI Unit should liaise with the Ministry of Planning and Development Cooperation to ensure that such parameters as estimated growth rates that SWLRI will be using are consistent with those used by MoPDC. The checking undertaken during Phase 1 of the data obtained has been limited to cross checking between sources, the national 10 yearly census being taken as the most reliable source.

Population and housing data has been received from the Ministry of Planning and Development Cooperation which includes the following:

- Total population for years 1957,1965 and 1970 to 2004
- Population broken down into total urban and total rural for each governorate for 1997 and 2004.
- Numbers of housing units and households broken down into urban and rural for 1997
- Numbers of housing units and households for each governorate for 1997.

Historic data indicates a past growth rate of about 3% per annum. Growth appears to have been fairly uniform. This rate of growth is used by the Ministry of Municipalities and Public Works to project future populations. The mini Master Plan for Basrah indicates that the Ministry of Planning projects future populations at a growth rate of 2.25% per annum to 2010 and 2.0% per annum thereafter.

3.2.5 Environmental Information

The main sources of information collected on environment in Iraq are UNEP, the Marsh Restoration Program and the New Eden Project. All of these have used experts from the local universities to provide material on habitats and species of interest. The future of the southern marshes is obviously a key issue for the strategic studies to be undertaken by the SWLRI Unit but there appears to be a considerable body of recent data from other projects to work from. Obtaining good data covering the period before the draining of the marshes is more problematic.

Dealing with the potential impacts of project opportunities put forward by the ministries (Section 9) will be an important task for both the Ministry of the Environment and for the SWLRI Unit. The ARDI team therefore discussed with the Ministry of Environment aspects of environmental legislation and procedures for assessing the potential impacts. The following series of questions were raised with the Ministry of the Environment to clarify these issues.

(i) Legislation

In order to understand the process for environmental management in both the development and operation of projects/facilities, it is necessary to understand the legal framework within which the Ministries are expected to operate. Although some standards have been identified for specific environmental parameters have been identified and uploaded into the Claromentis system, there is still a lack of clarity to us on the overall legislative framework.

Environmental Impact Assessment

In most countries there is a defined statutory Environmental Impact Assessment (EIA) process, which defines what projects require an EIA, what is expected contained within an EIA, responsibility for making decisions on the EIA process and a mechanism for making decisions on what is acceptable for new development projects.

Increasingly common is the requirement for Strategic Environmental Assessment, to incorporate environmental parameters into levels of planning which are higher than specific projects (e.g. development plans and long term programmes).

Based on discussions with delegates visiting the UK it appears that there is a process which involves environmental directorates within each governorate, however the details of this process are unclear, and it appears likely that this process will be reformed as the Ministry of Environment develops as an institution.

Questions:

1. Is there an existing formal process for the approval of projects, which takes into account environmental factors?
2. Are there any parameters for defining which projects/plans/programmes require an environmental assessment?
3. Is it possible to receive translated versions of any current legislation that addresses this process
4. Are the Ministry of Environment currently reviewing/developing such processes and if so is it possible to see their current drafts/thoughs on these processes?

Environmental Standards

In order to determine the significance of particular environmental impacts of proposed programmes of works and individual projects, it is necessary to understand the statutory requirements for particular environmental parameters. Some standards for water quality have been received, however it would be of great value to understand other limits set either by law or through other recognised standards (such as the World Health Organisation guidelines)

Questions:

1. For the following environmental parameters, how are acceptable limits defined for development projects?
    a. Protected areas (e.g. are there particular areas which are protected from environmental harm under national or international law – for example National Parks or Nature reserves)
    b. Protected Species (nationally and internationally)
    c. National monuments/archaeological features
    d. Water quality
    e. Noise
    f. Air Quality
    g. Soil Quality (e.g. soils of high agricultural value or limits for particular chemicals)
    h. Aesthetic quality (e.g. natural beauty)

Environmental Policy/Aspirations

In the case of the short term it is recognised that it may not be possible to address environmental impacts to the level which may be expected in many other countries, due to the urgent need and scale of reconstruction and rehabilitation required. In order for development proponents (such as the ministry of water resources) to set realistic targets for environmental management issues, it may be necessary to set short term environmental priorities and longer term environmental aspirations.

Questions:

1. Have any of any of the ministries created a set of environmental priorities which should be addressed in the short term?
2. Other than those identified for the short term, have longer term environmental aspirations been identified which should be considered in strategic planning?

(ii) Institutional Framework

Decision Makers

In order for the Environmental Assessment process to be effective (at both strategic and project levels) it is common for development proposals to be reviewed by a governing body in order to make a decision on the acceptability of the project.

Questions:

1. With a typical development project put forward by a ministry such as an irrigation project proposed by the Water Resources Ministry. What other bodies have influence on the decision to build the project?
2. Are environmental permits/approval required to begin construction and if so who issues such permits? (e.g. local authorities or national bodies)
3. If such permits/approvals are issued, are conditions attached to permits to set acceptable environmental limits for projects? (e.g. can be built as long as discharges to water contain less than a particular concentration of a chemical)

Regulators

Where environmental limits are set it is important to ensure that monitoring and measurement is carried out to determine if the limits are to be broken. It is assumed that the development proponent is ultimately responsible for this monitoring during construction and that the operator would be responsible in the longer term.

Questions:

1. Is the above assumption correct?
2. What agencies exist to regulate conditions applied to development projects?
3. Is auditing undertaken to determine if conditions are being met?
4. What actions are taken if conditions are not met?

Non Governmental Organisations?

In many systems non-governmental organisations play a key role in providing independent guidance on the acceptability of development projects and in some cases there is a statutory requirement for consultation with such bodies to ensure that the interests they represent are not adversely affected by a development programme or project.

Questions:

1. Are any NGO's consulted on development projects?
2. What environmental NGO's exist in Iraq?

Human Resources

Although it is possible for non-environmental specialists to contribute to the Environmental assessment process, there may be occasions where it is necessary for specialist environmental expertise to be used to assess particular problems.

Questions:

1. Who conducts environmental assessments? (e.g. Ministries, regulating bodies, consultants, universities etc)
2. Are there any competence requirements for environmental specialists to conduct assessments in Iraq (e.g. Register of Environmental Impact Assessment specialists?)
3. Which ministries have specialist environmental expertise?
4. Where expertises are not present in a particular ministry, where are they found? (e.g. do ministries employ expertise from universities, consultancies etc?)
5. Are any capacity building programmes in place to increase environmental skills within relevant ministries?

(iii) Environmental Parameters

In order to obtain an understanding of the key environmental issues in Iraq it is necessary to gather technical datasets on individual environmental parameters. Although the response to questions in section 1.2 of this note will increase our understanding of environmental aspirations and therefore influence what datasets are needed, the following are considered to be desirable (note that water quality data has not been included as this is requested elsewhere in the project)

Questions:

1. What data is available for fisheries in Iraq?
   a. Can data on all commercial fisheries species (large scale and small scale be provided)
   b. What information is available on non-commercial fisheries which are used on a local scale (e.g. informal fishing to supplement dietary needs of families)
   c. Information is needed on migratory patterns and routes. Published information appears to be scanty regarding the migration patterns and routes for the species in the rivers, tributaries and marshes. Can we get this information from local people or NGOs?
2. Is it possible to provide a schedule, including geographical locations of protected sites, including
   a. Ecologically sensitive sites such as wetlands or nature reserves
   b. Protected species
   c. Archeologically/culturally sensitive sites
   d. Any other protected areas?
3. Soil pollution data (e.g. land degraded by pollution from industry or military activity)?
4. Air quality data (particularly for urban areas)?
5. Land Use Data?

4 Agriculture and Irrigation

4.1 General

Agricultural data has been provided by the Ministry of Agriculture generally excluding the northern governorates, data from these has been provided by the Kurdistan Regional Ministry of Agriculture and Water Resources. The information from these two sources is difficult to compile into single data sets for the entire country because different parameters or different record periods have been supplied. In the planning context there is a need to develop an understanding of trends over time in the choice of crops, planted area for each crop, and yield (production). Some of the data is suitable for such trend analysis on a governorate basis.

There is at present no data on crop production from individual irrigation areas.

There is no data on the quantity and quality of irrigation return flows from individual schemes.

4.2 Summary of information received from the Ministry of Agriculture:

1. Comparison between 1971 and 2001 of:

   - Number of farms by governorate (unclear if these are private farms or farms rented from government)
   - Area of farms by governorate (suggested that this data may be unreliable as it shows a decrease in area over this time whereas due to sanctions restricting imports, the area probably increased)
   - Area of land cultivated in summer by crop (rice, cotton, sunflower and potatoes)
   - Area of land cultivated in winter by crop (wheat, barley)
   - Area of land used for production of fruit and date palms
   - Number of cows, buffalo, sheep, goats, camels

2. For each governorate by crop for winter and for summer for each year from 1995 to 2003:

   - Production (tonnes x 100)
   - Area cultivated (donums x 100)
   - Yield (kg/donum)

   Summary table of the above

3. Production, area cultivated and yields for each year from 1971 to 2001 for the whole country (excluding Kurdish area) for irrigated and rainfed areas (where applicable) for the following groups and crops:

   - Important crops (wheat, barley, rice, yellow corn, white corn)
   - Beans etc (maize, haricots, broad beans, chick peas, lentils, oats)
   - Oil crops (sesame, sunflower, linen/flax, pistachio, soya, safflower)
   - Industrial crops (cotton, tobacco, sugar cane, sugar beet)
   - Animal feed (alfalfa, berseem, other)
   - Vegetables (winter, summer)

- Spring potatoes, autumn potatoes, onion, garlic

4. Area cultivated by governorate for rainfed and irrigated areas from 1971 to 2002 (also 1990 to 2002).

5. Summary of land use for agriculture including:

- Cultivatable land
- Cultivated land (seasonal, perennial, irrigated, rainfed)
- Grassland
- Forest

4.3 Further Information Requested

In order to develop needs and opportunities data for the agricultural sector, and in particular for irrigated agriculture, the following questions were put to the MoWR and MoA:

4.3.1 General

1. Are there subsidies:
   i) for the irrigated agriculture sector;
   ii) for general agriculture.

2. For each region, has the area under irrigation over the last 5 years;
   i) increased;
   ii) decreased;
   iii) remained steady.

3. Are the methods and facilities for storage and distribution of crops adequate?

In addition, the following general questions were put forward:

- Is there a desire to improve irrigation efficiency by using different irrigation techniques?
- Is the main target to achieve economically/financially sustainable schemes?
- How important is food security?
- How important is employment generation?
- Would any new projects require World Bank (or other international donor) finance?

4.3.2 For Each Major Irrigation Scheme

1. Is the scheme fully operational? If not is this because of:

   a) lack of water;

i) all year;
ii) certain times of the year;

b) problems with water quality;
i) all year;
ii) certain times of the year;

c) shortage of land;
i) because of soils;
ii) because of salinity/drainage;
iii) because of flood susceptibility;
iv) because of erosion;
v) because of sand dunes;

d) is there any subsurface drainage, if so is it;
i) fully operational;
ii) partially operational;
iii) not working;

e) shortage of people;
i) all year;
ii) certain times of the year;

f) lack of capacity;
i) due to initial design;
ii) due to deterioration;
iii) is rehabilitation required;

g) trend – over the last five years has the irrigated area;
i) increased (give reasons);
ii) decreased (give reasons);
iii) remained approximately the same.

2. Are there any records to allow estimates to be made for irrigation efficiency as:
a) conveyance losses;
i) for unlined canals;
ii) for concrete lined canals;
iii) any other form of lining.
b) infield application efficiency.

3. Is there scope for expansion? If not which of the points under (1) represents the constraint.

4. How is the scheme currently managed:
a) by the state;
b) by the farmers;
c) by private companies;
d) other.

5. Operation and maintenance.
a) How is O&M controlled?
b) How is O&M paid for (water charges)?
c) Is it effective?

6. What is the current land-tenure situation:
a) do farmers own the land?
b) can agricultural land be brought and sold?
c) do farmers have traditional rights (usufruct)?

7. What are the constraints on improving yields:

a) water;
b) availability of other inputs (seeds, fertilizers, herbicides, pesticides);
c) seasonal labour;
d) salinity/water logging;
e) other.

8. How are the cropping patterns selected?

5 Groundwater

5.1 Introduction

Two Governorates – Sulaymaniyah and Erbil – provided most of information due to the fact that groundwater development has been most intense there from 2000 onwards. The development was a result of an FAO initiative. The MoWR provided about 3,600 scanned well cards – short descriptions of basic well data including coordinates, total depth, static water level, pumped water level, an outline lithology and some basic water quality parameters.

The Groundwater Studies Centre of the MoWR is currently undertaking work to install and operate a nationwide monitoring system. However, it is still not clear what is being monitored in 2006 and what had been monitored in the past, although there is rather more information for Erbil and Sulaymaniyah than elsewhere.

The MoWR GIS centre appears to have a number of geological and hydrogeological features mapped including well locations, presence of saline groundwaters, and water table depth, but these have not been made available in digital format for the ARDI team to perform independent checking.

5.2 Data Received

The information received from various sources and stored on Claromentis can be broadly divided into four main categories:

- Ministry of Water Resources, Baghdad
- Ministry of Agriculture and Water Resources, Sulayimaniyah
- Ministry of Agriculture and Water Resources, Erbil
- Data from other sources

5.2.1 Ministry of Water Resources (Baghdad) Data

Most of this information is in the form of electronically scanned well cards, short descriptions of basic well data. They have been recorded in Arabic although some contain English entries.

The categories of information provided by well cards include the following:

- Name of the well
- Governorate, project
- Coordinates (geographical)
- Total depth of the well
- Static water level (SWL)
- Pumped water level

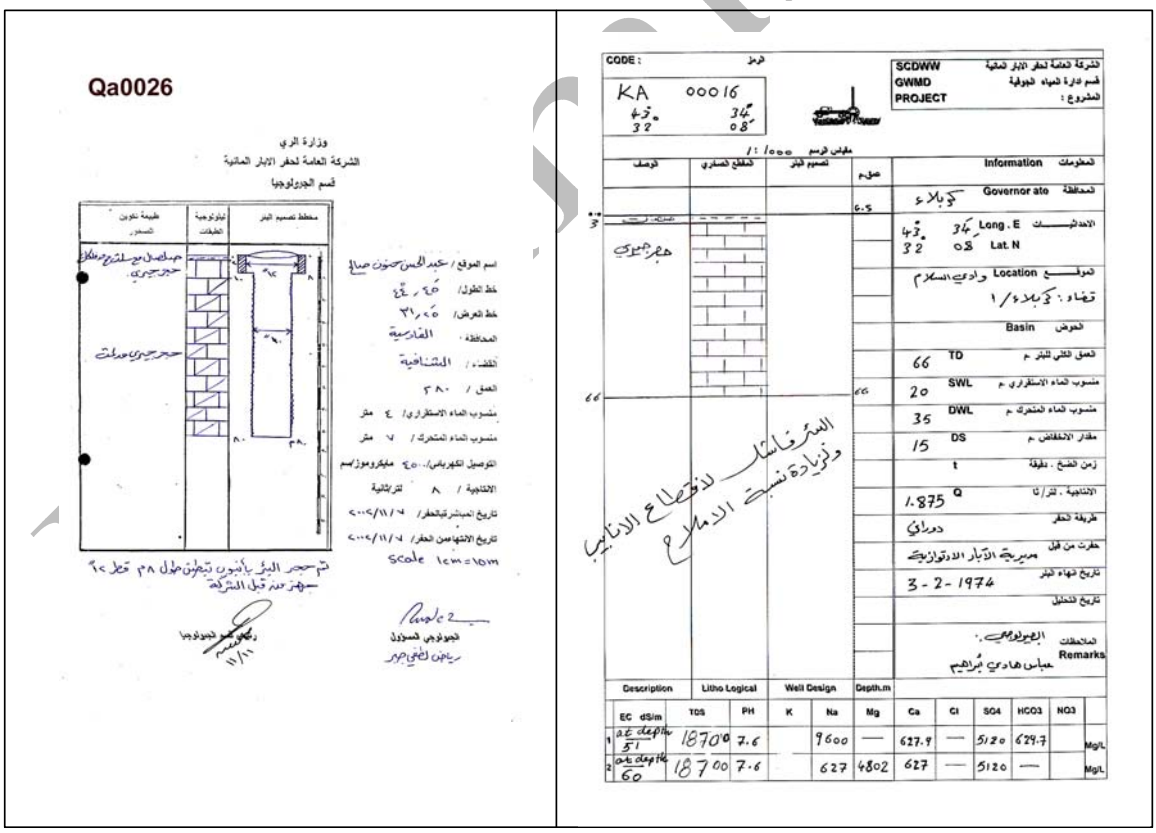
- Outline of encountered lithology
- Basic water quality parameters

Claromentis contains about 3600 well cards at present. The number of cards per governorate is shown below:

Table 5.1: Well Cards by Governorate

Governorate	Number of well records at MW
Al-Anbar	1041
Al-Muthana	563
Al-Najaf	646
Babel	132
Basrah	742
Dyala	9
Karbala	471
Qadsya	27
Total	**3631**

Some examples of well cards are shown below:



5.2.2 Sulaymaniyah Governorate Data

Groundwater and related information sourced from the Sulaymaniyah Governorate is tabulated below:

Information source	Type of information
Ministry of Agriculture and Water Resources, Sulaymaniyah, Deep Well Program Annexes	Groundwater level data, well depths, aquifer properties, pump rates
Ministry of Agriculture and Water Resources, Sulaymaniyah, Drillers Diaries	Approx locations, depths, casing, lithologies and drawdowns (with pumping) for wells
Ministry of Agriculture and Water Resources, Sulaymaniyah, Static Water Level Records	Water level data and charts, mainly for period 2000-2001
Ministry of Agriculture and Water Resources, Sulaymaniyah, p10	Average GWLs August 2000 to July 2001. Q and duration of pumping tests for April-July 2001
Ministry of Agriculture and Water Resources, Sulaymaniyah, Vol 1 and 2 annexes	Geological maps, cross Sections, stratigraphical columns, hydrogeological Maps
Ministry of Agriculture and Water Resources, Sulaymaniyah, Well Survey Cards	Well cards showing lithology and location of wells
Ministry of Agriculture and Water Resources, Sulaymaniyah,	Parts of FAO project
Ministry of Agriculture and Water Resources, Sulaymaniyah,	Average monthly rainfall, temp, pressure, evap 1992 - 1999
Ministry of Agriculture and Water Resources, Sulaymaniyah,	Rainfall, windspeed temp
Ministry of Agriculture and Water Resources, Sulaymaniyah,	Daily Rainfall for years 2001-2002 for different raingauges
Ministry of Agriculture and Water Resources, Sulaymaniyah,	Monthly rainfall data 2000-2004 for Kifri
Ministry of Agriculture and Water Resources, Sulaymaniyah,	Daily Rainfall for years 2002-2003 for different raingauges
Ministry of Agriculture and Water Resources, Sulaymaniyah,	Daily Rainfall for years 2001-2004 for different raingauges
Ministry of Agriculture and Water Resources, Sulaymaniyah,	Daily Rainfall for years 2001-2002 for different raingauges
Ministry of Agriculture and Water Resources, Sulaymaniyah,	Daily Rainfall, Humidity, Wind, Evaporation and Temp for 11 months of 2004 at Darbandikhan Dam
Ministry of Agriculture and Water Resources, Sulaymaniyah,	Daily Rainfall, Humidity, Wind, Evaporation and Temp for 3 months of 2003 at Darbandikhan Dam
Ministry of Agriculture and Water Resources, Sulaymaniyah,	Daily Rainfall data (2002-2003)
Ministry of Agriculture and Water Resources, Sulaymaniyah,	Daily Rainfall data (March 2005) for a number of districts
Ministry of Agriculture and Water Resources, Sulaymaniyah,	Daily Rainfall data for different locations, range of dates from 2000 +
Ministry of Agriculture and Water Resources, Sulaymaniyah, p11	Daily rainfall, wind, pressure, temp etc data for different months and locations in 2000-2002 in Sulymaniah
Ministry of Agriculture and Water Resources, Sulaymaniyah, p11	Monthly rainfall data in Kifri for Nov01 to April03, Monthly rainfall data in Kalar for October 00 to May 01
Ministry of Agriculture and Water Resources, Sulaymaniyah, p12	Monthly rainfall data for different stations from Sep01 to May 02
Ministry of Agriculture and Water Resources, Sulaymaniyah,	FAO Drilling Training Course 2002 Documents (including certificates and contents list for acheivements report)
Ministry of Agriculture and Water Resources, Sulaymaniyah,	Groundwater levels and well/aquifer information for certain wells. Levels not plotted.

Ministry of Agriculture and Water Resources, Sulaymaniyah, page 7	Well logs
Ministry of Agriculture and Water Resources, Sulaymaniyah	Statistical reports of deeps wells monitoring team (includes well location, depth, no of monitoring visits undertaken) + deep overall summary report

5.2.3 Erbil Governorate Data

Groundwater and related information sourced from the Erbil Governorate is tabulated below:

Type of information	Example	Electronic format
Pumping test data	"Long December" "Sort pump test Hamza 10"	Time and WL data in excel and word. Charts in excel.
Groundwater level data	"MW fluct of Erbil to 7 july"	Date and WL data in Excel with charts
Summary GW Reports	"The monthly report of july 7 2001"	Word
Contour Maps	"Contour map max only August 8.SRF"	Some appear to be ISIS files.
Pumping test data	"long test - july"	Time and WL data in excel and word. Charts in excel.
Average Daily Pumping Rates	"Monitoring Pumping Rate2 - feb"	Word
Groundwater level data	"Mwfluct of Erbil in Feb.2002"	Date and WL data in Excel with charts
Groundwater level data - summaries	"Monitoring Wells, Summary 5 - feb"	WL and Date - some in word, some in excel
Summary GW Reports	"The monthly report of April.4"	Word
Contour Maps		Surfer files
Pumping test data	"Banaman No.1 chart.xls"	Time and WL data in excel and word. Charts in excel.
Groundwater level data	"Flactuation February 03"	Date and WL data in Excel with charts
Average monthly GWL levels + Well depth + Geological formations + Pumping rates and durations	"monitoring monthly summeryñ1.xls", "Monitoring Pumping Rate.doc"	Summary tables in word and excel
Summary GW Reports	"The monthly report of August. 2003.doc"	Word
Contour Maps	"CONTOUR MAP OF MINIMMUM GWL IN ERBIL BASIN ONLY JULY 03.GRD"	Surfer files
GWL database	"data swl"	Excel spreadsheet containing WLs for all (?) wells in Erbil from 2000 -2003
GWL Summary sheets	"MONITO~3.XLS", In folder "GWL Summary sheets"	Excel spreadsheets with max and min GWLs for month, altitude, aquifer type, well code, Q

5.2.4 Other Sources

Information was also sought from various other sources. Some GIS information – at a national scale – was obtained informally from researchers who have conducted investigations on Iraqi groundwater in the past.

Other information was sourced from the GIS section of the MoWR but it is believed that more potentially valuable information is still available at this particular source.

Groundwater summary maps are also available from the recently published Geology of Iraq [Jassim, Goff, 2006], but these are only available as raster (jpg) files..

5.3 Further Data Requirements

In order to further understand the activities of the Groundwater Studies Centre at MoWR, and to clarify a number of points relating to the data then received, a series of questions were formulated and sent to Dr Sadik, Director of the Groundwater Studies Centre, and these were then followed up directly by telephone conversation with Dr Sadik. The record of this latter discussion is contained in Appendix B.

The questions posed were as follows:

Key questions:

- What tasks are the Groundwater Studies Centre currently undertaking?
- What monitoring of water levels and salinity is undertaken?
- Databases or GIS systems – are they in use for storing information?
- Planning groundwater abstractions/new wells – what is the decision-making process?

These questions are expanded in more detail below.

The text in boxes contains questions which require answering to further develop needs and opportunities. The bullet points outside the boxes summarized the ARDI team's understanding of the situation prior to any clarifications from Dr Sadik.

5.3.1 Where is groundwater used?

- Groundwater use in Iraq is small in proportion to surface water, but is more important in rural areas. It may be the only practical source of water in large areas of the country.
- There is a perception that groundwater is currently used mainly in the northern governorates including Erbil and Sulaymaniyah.
- Groundwater also used where surface water is not readily available, e.g. in Najaf, Anbar and Muthanna governorates
- There are wells located in other governorates
- Both deep (up to 150 m depth) and shallow hand dug wells are used

- Are there recent estimates of groundwater use for irrigation and drinking purposes?
- Are there differences in well ownership between sites/governorates?
- What are the proportions of private and public users?
- Has groundwater use increased; decreased or remained steady over last 5 years (for each region where groundwater is used)?

5.3.2 What is groundwater used for?

- Both agriculture and for drinking water

- Do the wells pump 24 hours a day or only for parts of the day?
- Do the pump hours vary for deep and shallow wells? Are the variations recorded?
- What flow rates are obtained? How do they vary? Are they recorded?
- If the water is used for agriculture, what area is irrigated per well?
- Who owns, maintains, updates abstraction records?

5.3.3 Planning new wells

- New wells deeper than 20 m require a permit to be granted by the Director of Groundwater for each Governorate (Muhabir)
- The new well must be more than 500 m from an existing well for the permit to be granted
- The Ministry of Water Resources examines hydrogeological maps for the area which contain information about the salinity, depth to water table and hydrogeology
- Permission to drill will then be granted
- Following the drilling a well permit must be completed and sent back to the Director of Groundwater. This contains a geological log, the location of the well and various measurements including static water level and water quality.
- We understand that the Groundwater Studies Center is currently undertaking a special study to perform a General Assessment Report, examining the renewability, quantity and quality of groundwater resources.

- Apart from the 500 m distance, what other criteria are used to determine if a permit will be granted?
- Are the proposed well locations georeferenced?
- Is the water required by the well assessed in relation to the potential resources available? How?
- What work has been undertaken by the Groundwater Studies Center on their special study to perform a General Assessment Report, to examine the renewability, quantity and quality of groundwater resources? How are the renewability, quantity and quality being assessed? What is the current progress on the study? When is it to be completed?

5.3.4 Record keeping

- The deep well permits are scanned and held as pdfs by the Director of Groundwater for each Governorate.

- Is there a central and/or regional (for example governorate-based) database of all the wells?
- How many deep and shallow wells are there? Per governorate?
- What pieces of information (database fields) are being populated?
- What information is stored in paper format and what is stored in electronic format?
- What is the proportion of paper-based information to electronic? Can you provide estimates?
- Is record collecting and keeping mandatory?
- Who is responsible for recording and record-keeping?
- Are there differences in record-keeping practices between deep and shallow wells?

5.3.5 Groundwater level monitoring

- We understand that the Groundwater Studies Centre is currently undertaking work to install and operate a nationwide monitoring system.
- We are unclear about exactly what is being monitored at present, and in the past, and where.
- We understand that in Erbil there may be around 15 to 25 years of monitoring data available – we are not sure exactly what has been being measured and where.

- What monitoring has been undertaken in different governorates and what is the current status?
- Is there an existing network of monitoring wells?
- Are both pumped wells and wells without pumps monitored?
- When water levels are measured where is the information stored? Is it held in a database? By who – the governorate or ministry?
- Have any studies been undertaken to recommend monitoring strategies and procedures?
- Are these studies being implemented? Where?
- What work has been done so far by the Groundwater Studies Centre in relation to the monitoring network? Has a system been designed? Has any equipment been installed as part of this work?

5.3.6 Problems with the wells

Salinity

- Groundwater salinity is increasing in many areas

- Which areas are salinity-affected?
- Is the salinity routinely measured in the wells?
- If so how often and what is the basis of the monitoring regime?
- Where is it measured?
- Where and how is the data stored? Electronically (in a database?)
- Are changes in salinity over time being measured? What trends have been observed? Which areas of Iraq are showing increases in salinity?

Falling Groundwater Levels

- There were four years of drought between 1999 and 2002.
- These caused the groundwater levels to fall
- Since 2002, the amount of water recharging the aquifer has not been sufficient to allow the water levels to rise back up again. The levels are continuing to fall due to increased demand.
- The average abstraction exceeds the recharge

- When groundwater levels fall are the pumps lowered and/or boreholes deepened?
- Which areas were affected by drought?
- What was the magnitude of groundwater level decrease between different areas/governorates?
- Were sustainable yields determined for public and private sources?
- Is recharge/replenishment routinely assessed, if so what methods are used?

Sewage

- Erbil has problems with sewage contaminating groundwater

- Are maps available showing the locations in Erbil particularly affected by sewage contamination of groundwater?
- What is the source of the sewage? Is it a treatment works, septic tank, soakaway etc?
- Are there any guidelines about the location of new wells in relation to sewage?
- Are there problems with sewage contamination in other places in Iraq?

Other Pollution Issues

- Is there a groundwater pollution prevention strategy applicable to oil extracting and processing facilities?
- Has vulnerability of groundwater resources been assessed at a national or regional scale?
- Is zoning strategy considered and/or applied to groundwater supplies?
- What are the analytical determinands routinely used to assess groundwater pollution?
- Is the laboratory infrastructure capable of dealing with analytical demands resulting from groundwater pollution studies and routine monitoring?
- Has there been an international cooperation aimed at groundwater pollution studies in Iraq?
- Are there corrosion and scaling problems associated with groundwater, if so which areas are affected?
- Can you describe past and current pollution control practices in Iraq? Is polluter-pays principle applicable?
- Is the data on land use available at a national or regional scale? If so is it transferred to GIS systems?

5.3.7 Recharge estimation

- Have any recharge assessment studies been done in Iraq? Can you provide references or copies of reports?

5.3.8 Other information required

- What is the status of education in groundwater resource assessment and management? Are there university courses covering groundwater topics in Iraq?
- Can you provide an estimate of the number of groundwater specialists in Iraq?
- Are there public or private consulting firms engaged in groundwater exploration, assessment and management?
- Who is the key fund provider for groundwater exploration?
- Is research funding available for groundwater problems in Iraq?
- Recharge dams – have there been any studies or is there any anecdotal evidence into whether they have been successful? Are there siltation and/or salinisation problemes associated with existing recharge dams?
- We understand more recharge dams are being planned in the north – how are the cost/benefits being assessed?
- Is there a consistent pricing policy for groundwater resources? If so can you describe / provide references to its key elements?
- Are there state subsidies to develop or manage groundwater resources
- Are you aware of trans-boundary issues related to groundwater resources? (for example, borders with Turkey, Iran, Kuwait)

6 Water Supply Information

6.1 Existing Municipal Water Supplies (Information and Data)

6.1.1 Data from the Ministry of Municipalities and Public Works

The Ministry of Municipalities and Public Works (MMPW) has provided a list of water treatment plants, wells and compact units for 15 governorates. There is no equivalent data for the three Kurdish governorates of Dohuk, Erbil and Sulaymaniyah. Data for each facility include location given by coordinates, planned output, actual output and numbers of people served. From discussions with MMPW it is understood that the list is probably far from complete, although it is believed to be the most comprehensive list available. There is a reasonable correlation between the number of water treatment plants in the list and those recorded in specific plans for individual governorates, but the number of compact units (CUs) varies widely. It appears that CUs are put in by various organisations without any real coordination or record keeping

A weakness of the MMPW list is that it does not indicate which town(s) each treatment plant serves, nor the source of water for each works. There are coordinates for the location of each works, but these are unreliable, and in any case the treatment plant does not necessarily serve the area in which it is located, or the source of raw water may be far from the works.

Analysis of per capita consumption (pcc) from data for outputs and people served in the MMPW list shows a very wide range with many anomalous figures, e.g.

- For water treatment plants, the calculated pcc varies from 24 to over 10,000 litres per person per day (lpcd).
- The variation is even more extreme for CUs.
- In 8 governorates (over half of those for which data are supplied) the average pcc is 333 lpcd for all works. The governorates with this figure throughout are Al Anbar, Baghdad, Basrah, Diyala, Maysan, Muthanna, Qadisiyah and Salah al Din. We assume that 333 is a target figure for supply, and population served is calculated from measured/estimated works output or actual output is calculated backwards from population served.

6.1.2 Mini Master Plans

Water supply mini master plans have been or are being prepared for the governorates of Basrah, Erbil and Sulaymaniyah and copies have been provided. A wastewater plan has been prepared for Karbala and copy of that has also been provided. Further plans are due to be completed for water supplies to, Najaf, Diwania and Kirkuk

Despite their name, these plans appear quite comprehensive, although their coverage varies. That for Basrah covers the whole governorate with the focus on the municipality of Basrah, whilst those for Erbil and Sulaymaniyah cover the governorate except for the main towns of Erbil of Sulaymaniyah. The wastewater mini master plan for Karbala is only for the main town.

A very brief outline of the planning criteria used and water requirements for each plan is given below.

(i) Basrah

The basic demand criteria used for Basrah were as shown below.

Table 6.1: Planning Criteria for Basrah Demand Forecast

Location	Level of Service Factors (l/c/d)				
	Domestic	Commercial	Industrial	UfW	Total
Basrah	300	30	30	72	432
Towns with industry	200	30	30	52	312
Towns without industry	200	30		46	276
Rural	200			40	240

There is no indication whether these figures are average or peak daily demands. It is assumed that they are peak figures as they are used to establish capacity requirements.

The population of the governorate is projected to rise from 1,761,000 in 2003 to 3,375,000 in 2025, using a growth rate of 3% per annum in line with that used by MMPW. Applying the above figures for per capita water demands to the projected population gives a present total peak daily water demand of about 650,000 m^3/d rising to 1,167,400 m^3/d by 2025.

The mini master plan examined seven options for meeting this demand and recommended a combination of conventional treatment of water from the River Tigris at Al Quorna and desalination of water from the Shat al Arab in Basrah. It is proposed that normally 40% of the water will come from Al Qorna and 60% from the Shat al Arab. The different supplies will be blended to give a potable supply meeting Iraqi and WHO guidelines.

(ii) Erbil

The population of Erbil is expected to grow from its current level of about 1,600,000 to 2,900,000 by 2025. This is a growth rate of 3% per annum. The urban centres, outside the city of Erbil itself, have a present population of about 250,000 and this is projected to rise to 437,520 by 2025.

The overall per capita demand for people in the district centres is taken to be between 360 and 390 l/d and applying these figures to the population forecast gives a total demand rising to 160,216 m^3/d by 2025. The total demand from sub-district centres is forecast to be 52,861 m^3/d by 2025. No water demand figures are given for rural areas, although it is noted that about 28% of the total population of the governorate are classified as rural.

Proposals for development of water supplies generally anticipate increases in abstractions from existing local sources, which are a mixture of springs, rivers and groundwater.

(iii) Sulaymaniyah

The population of Sulaymaniyah is expected to grow from its current level of about 1,800,000 to 3,300,000 by 2025. This is a growth rate of 3% per annum. The urban centres, outside the city of Sulaymaniyah itself, have a present population of about 257,000 and this is projected to rise to 464,171 by 2025.

The overall per capita demand for people in the district centres is taken to be 360 l/d and applying this figure to the population forecast gives a total demand rising to 167,101 m^3/d by 2025. The total demand from sub-district centres is forecast to be 521,972 m^3/d by 2025. No water demand figures are given for rural areas, although it is noted that about 20% of the total population of the governorate are classified as rural.

Proposals for development of water supplies generally anticipate various new surface water and groundwater sources. Sources will generally be local to the communities supplied.

6.1.3 New Eden Project Information

The reports provide data on existing systems and estimates for the development of water and sanitations systems. Although costs are given, there are no projections of water demand or lists of schemes in the main report.

The criteria for water demand assessment are given in the report as follows:

- Governorate headquarters 450 lpcd
- District capitals 360 lpcd
- Rural communities 250 lpcd

These are similar to those used in the mini master plans and were agreed with MMPW. They are assumed to overall peak day demands, including an allowance for unaccounted for water (UfW).

6.1.4 Information from the Reconstruction Project in Southern Iraq

As part of its work on the reconstruction project in Southern Iraq, Mott MacDonald has worked on water sanitation projects in Basrah, Thi Qar, Al Muthanna and Maysan governorates. As part of this work, outline plans were prepared for the development of water and sanitation systems in these four governorates in 2004.

The figures in the table below were used as an initial guideline for assessing water requirements and the adequacy of existing systems.

Table 6.2: Suggested Long Term Planning Criteria

Item	Per capita water demand (l/day)	
	Urban areas with developed internal plumbing systems	Rural areas with limited internal plumbing systems
Household demand	160	120
Non-household demand (industry, commerce, institutions, etc.)	40	20
Total consumption	200	140
Unaccounted for water	67	47
Total water requirement (average day)	267	187
Total water requirement (peak summer day)	335	237

The figures in the above table assume unaccounted for water is 25% of water production, which is a reasonable, but certainly not demanding target. The average per capita household consumption assumes a reasonably careful use of water and is based the normal requirements for household use. The figures used are also similar to figures which Mott MacDonald has recently used for a master plan for Oman. The summer peak assumes a 40% increase in average household demand, reflecting the extremes in temperature, and a 10% increase in non-household demand.

6.1.5 Analysis of Data

The following table summarises the data in the MMPW lists for 15 governorates and provides comparisons with data from other sources.

Table 6.3: Summary of Data on Existing Water Supplies

Governorate	Actual capacity from MMPW list (m3/d)				Population 2004	Capacity per person (l/d)	Capacities from other sources (m3/d)		
	WTP	Well	CU	Total			New Eden	Mini MP	MM 2004
Al Anbar	326,561		96,240	422,801	1,328,776	318			
Babil	71,760		26,256	98,016	1,493,718	66			
Baghdad	235,591		113,460	349,051	6,554,126	407			
Baghdad municipality	2,208,000		113,000	2,321,000					
Basrah	476,206		371,540	847,746	1,797,821	472	850,000	555,600	n/a
Diyala	308,465		65,050	373,515	1,418,455	263			
Karbala	215,270		30,720	245,990	787,072	313			
Al Tamim (Kirkuk)	383,140	7,000	30,840	420,980	854,470	493			
Maysan	56,314		89,640	145,954	762,872	191	271,656		197,000
Al Muthanna	83,138		16,920	100,058	554,994	180			86,000
Najaf	257,300		21,140	278,440	978,400	285			
Ninawah	603,217	22,059	62,068	687,344	2,554,270	269			
Qadisiyah	210,352		39,185	249,537	911,641	274			
Salah al Din	228,930		54,060	282,990	1,119,369	253			
Thi Qar	108,340		116,832	225,172	1,472,405	153	308,000		129,000
Wasit	174,300		52,794	227,094	971,280	234			
Total	5,946,884	29,059	1,299,745	7,275,688	23,559,669	309			

Notes:

1 Population data from Ministry of Planning figures

2 New Eden : new Eden Master plan for Integrated Water resources Management in the Marshlands Area, April 2006

3 Mini MP : Drinking Water Supply Mini Master Plan, CH2M Hill/Parsons, 2005.

4 MM 2004 : Data from Mott Macdonald's outline plans for the four southern provinces, 2004.

Although only limited comparisons between different data sources are available, it is clear that there are wide differences in several places where such comparisons are possible. The New Eden Project generally gives significantly higher figures than the MMPW list, whilst the Basrah Mini Master Plan and the Mott MacDonald data from 2004 appear generally to give low figures.

In some cases, the differences may be due to the coverage of the reports e.g. Mott MacDonald's work was focussed only onthe main towns. Another possible source of error is the number of operating hours assumed each day. The data in the New Project reports is given in m^3/hour, and the figures in the table above assume 24 hours per day operation and make no allowance for outages. We understand, however, that some works operate only in daylight hours.

The data from the MMPW list indicates that average per capita supply capacity is just over 300 lpcd, but varies widely between governorates from a low of 66 lpcd in Babil to a high of 472 in Basrah. The figures suggest that the overall supply capacity in many governorates should be adequate to maintain at least a good basic level of service to most of the population. However, reports suggest that this is rarely the case due to a variety of reasons including inequitable distribution of water, high levels of leakage, frequent loss of supply due to loss of power, and reduced operating hours due to security problems.

About 18% of the total capacity is from compact units (CUs). These are prefabricated steel plants with a limited lifespan, perhaps only 10 years. The New Eden Project reports record the condition and performance of the works and many CUs are classified as 'poor' in both respects. It is likely that a major programme of replacement of these plants with more robust conventional plants will be required in the coming years.

6.1.6 Industrial Water Supplies

A limited amount of information has been received from the Ministry of Industry and Materials. Tabulated data collected describes each industrial water user, the source of the water, the volume used, the volume discharged and a description of the discharge location. There are 107 records, but not all have complete information. Unfortunately the list does not indicate what units are used for measurement of abstractions and discharges, nor the location of the industry, although a separate list gives longitude and latitude references for a few companies. There are several major water consumers with private supplies in the chemical, petroleum, iron & steel, sugar refining and cement industries.

6.1.7 Existing Wastewater Collection and Treatment Facilities

Data on wastewater systems is only available from other reports. In general, piped sewerage schemes serve district headquarters but are limited in extent and wastewater treatment plants serve only parts of the major towns and often perform poorly if at all. Many house have septic tanks but these are often badly maintained and rarely emptied, and much wastewater is discharged to open drains. The situation on sewage treatment in the four southern provinces has been complied from reports on the New Eden Project and from the work of Mott MacDonald in 2004. The situation is summarised in the table below.

Table 6.4: Sewage Treatment Plants in Four Southern Governorate

Governorate/town	Capacity (PE)	Remarks
Basrah		
- Hamdan WWTP, Basrah city	400,000	Poor condition, partial treatment only
- Khur al Zubair	100,000	Not working
Thi Qar		
- Nasariyah	85,000	Not working
- Ali Askan Al Sinaie	10,000	Acceptable
Maysan		
- Amarah	150,000	Acceptable
Al Muthanna		
- Samawah	n/a	Two works dedicated to residential complexes only

We understand the situation in the four southern provinces is not atypical and clearly the collection treatment and disposal of wastewater in an environmentally acceptable way will require massive investment.

6.2 Further Information Needs

6.2.1 General information

Basic socio economic information is required to assist with assessing demands in various locations:

Additional data required:

i. Population data, including major urban areas and urban/rural split by governorate

ii. Numbers of houses with internal plumbing and flush toilets in urban and rural areas, by governorate.

6.2.2 Existing Water Supply Systems

We have a list of treatment plants, wells and compact units for 15 governorates. The title of the spread sheet states it is 'for all governorates', but there appears to be no data for three governorates. The missing governorates appear to be the three northern governorates covering the Kurdish Region.

It is not known what town(s) each treatment plant serves. It would be helpful to identify water supply systems. These may be for individual towns or in some cases several towns served as part of a single system.

There are some anomalies in the data e.g. if we calculate per capita water consumption we get an enormous range of values (0 to 15,724 lpcd). There are clearly many unrealistic figures at the extremes of the range. Furthermore, in some provinces most, if not all, WTPs provide a per capita supply of 333 l/day. It is assumed that in these cases either output has been worked back from population served or vice versa.

Additional data required on existing water supply systems:

iii. Lists of water treatment plants and wellfields for the three northern governorates

iv. Source of water for all treatment plants.

v. Towns/water supply system served by each water treatment plant

vi. Details of water treatment processes

vii. Clarification as to how the actual output and population served have been calculated and how the quality of data might be improved

viii. Details for distribution pipework (lengths and condition) for each water supply system/town.

ix. Numbers of consumer connections in different categories (households, industry, government, etc.) to each system and/or in each town.

6.2.3 Present Consumption Data

Present consumption levels by different types of consumers and water losses are the basis of future planning. At the present we have very little data. As noted above, the list of water treatment plants/CUs/wells gives anomalous data on consumption levels. We appreciate that few supplies are presently metered and good data may not generally be readily available.

Additional data required on present consumption and production:

x. Breakdown of water consumption between household and non-household (industrial, commercial, institutional) customers, and unaccounted for water (leakage and other losses). Ideally we would like this by water supply system, but any information would be useful.

6.2.4 Industrial Water Supplies

We have a list from the Ministry of major industrial water supplies but some key information is lacking.

Additional data required on industrial supplies:

xi. Location of each industry listed.

xii. Units for volume of water used.

6.2.5 Water Quality

We have readings from nine governorates for June 2005 (maximum, minimum and average values). Our main interest will be in salinity, and we would like some indication of annual variation and perhaps long term trends, if available.

Additional data required on water quality:

xiii. Annual maximum, minimum and average values for the main water quality parameters (TDS, Turbidity, pH, Ca, Mg, Alkalinity, Cl) for all water supply systems.

xiv. Trends in salinity over the past 10 years say where data is available.

6.2.6 Wastewater

The coverage of sewerage and wastewater treatment facilities obviously lags well behind the provision of public water supply systems and major investments will be needed in the future. We have no information on existing municipal wastewater treatment plants.

We have a list of industrial discharges but there are no units for volume discharged and the final discharge point is not clear (several say discharge to storage)

Additional data required on wastewater collection and treatment facilities:

xv. A list of existing wastewater treatment plants - location, design capacity, actual dry weather flow, treatment process and discharge point.

xvi. Lengths of the sewerage network in each town, numbers of connections.

xvii. Industrial wastewater – location of works, units for volume discharged and final discharge point

7 Hydropower Information

7.1 Data Received

The collected data was almost complete and was used successfully to build and test a workbook for hydropower energy and power calculations. The data set would have been complete but for some untidy scanning which meant that the static head values for a number of installations were missing. This missing information has been requested.

The installed capacity, annual energy generation, annual hours of generation, static head values and expected capital costs have been obtained for the 7 existing and 68 potential hydropower stations in Iraq. These figures were obtained from a spreadsheet provided by the Ministry of Energy in Iraq. This data is assumed to be current and accurate; however there is limited information available regarding the assumptions used to create these estimates. It is uncertain when the cost estimates were developed and these could have changed substantially. It is assumed however that for cost comparison purposes this data is sufficient. The assumed operating rules are also unclear and may be driven by demand for irrigation flows. The level of consideration for the interaction of these issues is unclear and could have a substantial impact on costs and benefits associated with the hydropower schemes. With these issues in mind, the data from the table has been used to give an indication of some of the possible scenarios for hydropower development in Iraq from now until 2030. As the accuracy of the input data is improved, the scenarios can be updated and more accurate conclusions can be reached.

7.2 Further Data Requested

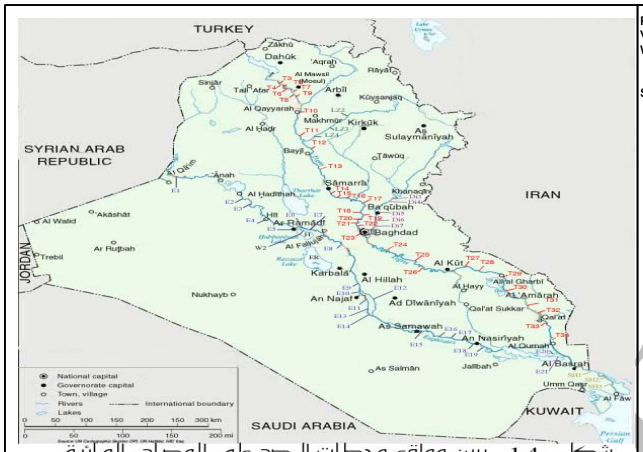
Details of studies and plans from the Ministry of Energy were needed which showed the plans for rehabilitation, upgrading, and new schemes to meet projected electricity demand by sector in the short and long term future. The ARDI consultants also wanted to review the energy sector study (covering all types of generation) and planning documents and so determine how to include hydropower in the Phase 1 efforts for strategic water resources planning.

8 Water Quality and Pollution Information

8.1 Surface Water Quality Data

Sample data for a number of stations on the river system was available. However, grid reference information was lacking, causing difficulties in correlating data from General Scheme with data sheets provided by ministries.

The map below shows recent sampling sites and the table the relationship to the General Scheme measurement points (neither source of information giving grid references).



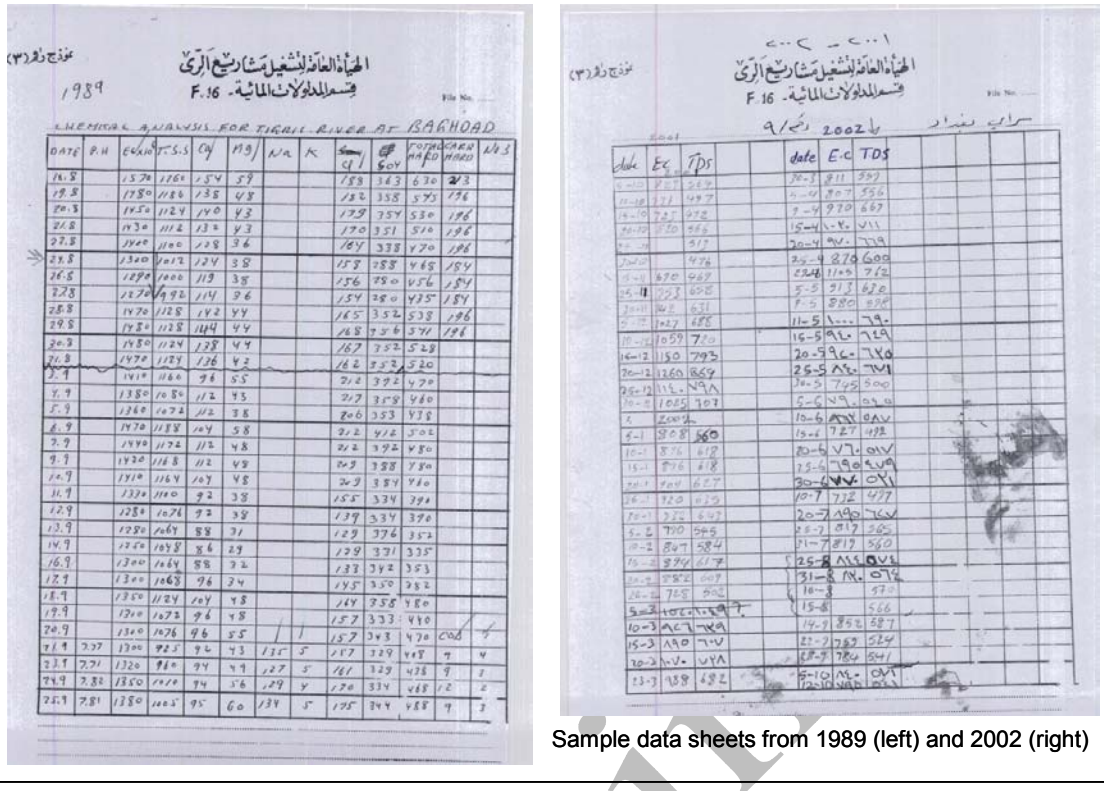
شكل 1.4 يبين مواقع محطات الرصد على المصادر المائية في العراق

Ref: General Scheme of Water Resources and Land Development in Iraq
Volume VII - Water and Land Conservation Book 1
Water Quality Data for 1978

Site no.	Description	River	Table no.	Corresponding station(s)
0	Tusan	Tigris	2.8	
1	Mosul (U/S and D/S)	Tigris	2.8	T7, T8, T9
3	Eski Kalak	Greater Zab	2.13	
5	Fatha	Tigris	2.9	T12
6	Dokan Reservoir	Lesser Zab	2.13	L22
7	Lesser Zab	Lesser Zab	2.13	L23, L24
8	Samara (U/S and D/S)	Tigris	2.9	T14
9	Adhaim Mouth	Adhaim	2.13	T16
11	Baghdad (U/S, Within, D/S)	Tigris	2.11	T22, T23
12	Derbendi Khan Reservoir	Diyala	2.13	D13, D14
13	Usptream of Baquba	Diyala	2.14	D15
14	Diyala Mouth	Diyala	2.14	D17
15	Kut (U/S and D/S)	Tigris	2.12	D26, D27
16	Amarah	Tigris	2.12	T30
18a	Al Khaim (Syria Border)	Euphrates	2.15	E1
18	Haditha	Euphrates	2.15	E2, E3
19	Ramadi	Euphrates	2.15	E5
20	Thar-thar Euphrates Canal	Euphrates	2.15	E6
21	Hindiyah (U/S and D/S)	Euphrates	2.16	E9, E10
??	Shinafiyah	Euphrates	2.16	
22	Samawa	Euphrates	2.17	E15
23	Nasirriyah (U/S and D/S)	Euphrates	2.17	E18, E19
24	Qurna	Euphrates	2.17	E20, E21
??	Qurna	Shat al Arab	2.18	SH1
??	Basrah (U/S and D/S)	Shat al Arab	2.18	SH2
??	Fao	Shat al Arab	2.18	SH3

Hand-written water quality record sheets were received for various monitoring points on the Tigris and the Euphrates.

The data was provided as scanned copies of original data sheets. There was a clear deterioration over time with more comprehensive records for earlier periods as shown by the two sample sheets from Baghdad below.



Sample data sheets from 1989 (left) and 2002 (right)

The periods of data covered in the records are shown in the following table. The time interval between samples varied between the monitoring stations, and also over time at each station varying between monthly data and as frequent as daily data for some periods of record, although there are extensive periods of missing data. The lengths of the data sets shown below are for the salinity or conductivity data records although further data series are present at most sites for other water quality parameters. This inconsistency in sampling frequency has consequences for the suitability of the data for some uses.

Table 8.1: Availability of Water Quality Data Series for River Monitoring Points

River	Location	Period of Record
Tigris	Srai Baghdad	1971-2000
	Amara	1977-2002
	Baghdad	1979-1990
	Mosul	1971-2001
	Samarra Barrage	1974-2001
Shat al Arab	Al Qurna	1971-1990
Euphrates	Al Hindiah Dams	1971-1998
	Al Ramady Dams	1971-2001
	Al Samawah	1973-2002
	Di Qar	1978-2002

None of the monitoring points was given a grid reference to show precisely where the sample had been taken. In fact 23 other record sheets were available but the gauging locations were not clearly identified on the sheets.

These monitoring points are all on the main river systems. No data has been collected during Phase 1 that relates to the water quality in lakes and reservoirs, or any measurements giving the quality of waters in the canal and drainage systems. Information on the quality of drainage returns is of particular interest for agricultural planning and the lack of data is surprising.

The lack of water quality data was a constraint to the development of models during Phase 1. There is more discussion of these issues in Annex 11.

8.2 Groundwater Quality Data

There was very limited information received from the Ministries on groundwater quality.

9 Opportunities Data

9.1 Information Received

The limited data on opportunities was reviewed with the visiting MoWR staff in May/June 2006 as part of the process of developing the Iraqi multi-criterion decision model (MCDM).

The data available came from three sources:

- The MoWR web site (downloaded February 2006)
- Two lists, one for MoWR and one for MMPW, prepared during the period of the CPA administration – these were provided through IRMO
- A list of some 12 projects in all sectors provided by the Ministry of Planning and International – this contained three water sector projects including Bekhme Dam

The MoWR web site contains a number of lists of potential projects according to a proposed year for start of implementation. There are a total of 262 projects listed ranging from the supply of computers, through rehabilitation works, to major multi-purpose dams and new irrigation and drainage systems. Figure 9.1 presents the spreadsheet from the web site for the year 2005 to illustrate the format and level of detail available.

The CPA period documents present a relatively small number of major schemes set out in a format to be presented to potential donors, it is understood that these two documents were prepared for an intended donor conference that was never held.

These lists were discussed with the MoWR visitors. From these discussions it appeared that most of the projects had been proposed at the time of the General Scheme Stage 2 (Russian report, 1982) and had not been taken further since then. This suggested that a major exercise would be required to check the existing engineering designs, to revisit the economic analyses, and to prepare environmental impact assessments and any other studies that might be required if the project were to be considered a candidate for international donor financing (e.g. World Bank safeguards policies).

9.2 Further Information Required

By June 2006, it was clear that there were still significant gaps in the information received, which required filling before comprehensive needs and opportunities data sets could be developed. A special meeting of the Data Collection Leaders was held in Baghdad on 19th June at which the ARDI team raised the following issues:

1. **Policies and likely direction of development in each sector** – needed to guide the preparation of the strategy and at this stage needed to help the ARDI consultants develop appropriate tools for subsequent strategy development.
2. **'Opportunities' (proposed projects) for ministries** – needed to include in the scenarios of possible alternative short and long term strategies. The ARDI consultants needed to know what projects were currently under study and how to access the information being prepared by the study teams

Each of these points is described in more detail below.

(i) Policies and likely direction of development in each sector

It was recognised that the delegates to the meeting might not be in a position to provide guidance on their ministry's existing policies, and more importantly on likely directions in the future. The key question for the MoWR SWLRI Unit and the ARDI consultants was how to obtain this information – a mechanism was needed that could deliver at least preliminary information to guide the ARDI team by the end of June at the latest.

Examples of the issues of concern to the consultants include:

- Charging for water use – what is current thinking on charging consumers the 'real' cost of their water use including agriculture and power. Do the ministries involved consider higher water charges in their future planning exercises?
- Food security – how is this viewed now, and in the future? To what extent should food security drive agricultural production?
- Hydropower – what role should it play in the future for electricity generation?
- Environment – what value should Iraq place on environment now and future? How are social needs and environmental needs to be weighed against each other in the short term, and in the longer term?
- Employment and poverty reduction – to what extent should projects that create agricultural employment be favoured as meeting socially desirable goals?
- Health targets eg access to clean drinking water, provision of safe sewage disposal

(ii) Opportunities

Each ministry was requested to make a list of ongoing studies, or recently completed studies, of projects and to name a direct point of contact for the SWLRI Unit and the ARDI consultants to talk to about the studies. It was suggested that it would also be useful to have a contact in each ministry's own section responsible for developing their plans for future developments. These names would be in addition to the Steering Committee Delegate and the Data Collection Leader, and would help to speed up the process of gathering the right information on opportunities.

Figure 9.1: Sample List of Potential Projects from the MoWR Web Site

Projects 2005

Project Title	Ministry ID	PMO ID	LOCATION(GOVERNORATE)	Description	Total Estimated Project Cost	SDate	EDate
Al Hindiyah Barrage	Barrage-004		Babylon	Al Hindiyah barrage is one of the 4 barrages with hydropower and it has 4 regulators upstream respor	$969,000	06/01/2005	8/31/2005
Al Kufa and Al Abasiya Regulators - Rehabilitation	Reg-001	W-R-WR-Dam-276	Najaf	Rehabilitation of regulators which water to supply local irrigation systems. To maintain water levels up	$888,000	02/01/2005	7/31/2005
Al Kut Barrage Complex	Barrage-006		Kut	The Barrage serves to maintain the water surface for the Gharaf. Rehabilitate gates from various barr	$3,000,000	06/01/2005	8/31/2005
Arar Dam Construction	Dam-032	W-R-WR-Dam Rural-183	Anbar	Construction of earth fill dam on Wadi Arar in the western desert. Dam would be 1,300 meters in leng	$8,752,000	01/01/2005	8/31/2008
Badoosh Dam (Phase II)	Dam-008		Ninewa	Phase II includes adding hydropower generaton to the dam. Elevate dam level to 256 m to store .5 bil	$35,000,000	02/01/2005	7/31/2006
Construction of 30 projects for protection of river bank erosion	IR-009		Suliamaniyah	Construction of 30 projects for protection of river bank erosion	$500,000	06/01/2005	11/30/2005
Construction of 40 water collection tanks	IR-004		Suliamaniyah	Construction of 40 water collection tanks. Tanks will store spring water at night for distribution during t	$400,000	04/01/2005	6/30/2005
Construction of 5 drainage projects	IR-008		Suliamaniyah	Construction of 5 drainage projects	$4,000,000	06/01/2005	11/30/2005
Construction of Komospan Dam	Dam-020		Duhuk	Construction of Komospan Dam for irrigation, hydropower, water storage purposes. Earth fill dam = Ir	$10,000,000	01/01/2005	6/30/2007
Dam Program Project Security	Dam-034	W-R-WR-Dam-093	Nationwide	Provide appropriate level of project security, system-wide. Provide full time armed security at all of the	$1,421,000	05/01/2005	7/31/2005
Falluja Barrage Rehabilitation	Barrage-007	W-R-WR-Dam-274	Anbar	Falluja Barrage controls the elevation of the water for 6 major irrigation systems. There has been no r	$1,776,000	01/01/2005	3/31/2005
Horan 1/2 Dam Construction	Dam-017	W-R-WR-Dam Rural-181	Anbar	Construction of earth fill dam on Wadi Horan in the western desert. Dam would be 650 meters in leng	$1,859,000	01/01/2005	6/30/2007
Irrigation improvement by using drip systems	IR-007		Suliamaniyah	Irrigation improvement by using drip systems	$3,000,000	04/01/2005	6/30/2005
Irrigation improvement by using sprinker systems	IR-006		Suliamaniyah	Irrigation improvement by using sprinker systems	$2,600,000	01/01/2005	3/31/2005
Kalar Reclamation Project	Major-014	W-R-WR-Major-219	Suliamaniyah	Rehabilitate existing irrigation network (lining of canals, other related structures). Irrigation is by pump	$7,000,000	06/01/2005	11/30/2006
Kassara Cross Regulator Rehabilitation	Reg-008	W-R-WR-Dam-255	Missan	Rehabilitate cross regulator to restore safe operations, raising upstream water levels and regulating d	$3,997,000	02/01/2005	7/31/2005
Kirkuk (Contract 24) - Various Projects	Major-002	W-R-WR-Major-202	Salah al-Din	Improve land production in this region; provide water resource; improve decreasing ground water leve	$14,282,000	01/01/2005	3/31/2005
Mahrut (Phase I)	Major-008	W-R-WR-Major-208	Diyala	Improve land production in this region; provide water resource; improve decreasing groundwater level	$15,988,000	01/01/2005	3/31/2005
Mandali Dam Construction	Dam-009	W-R-WR-Dam Rural-190	Diyala	Construction of earth fill dam at Mandilee in the eastern region. Approximate storage capacity equals	$4,441,000	01/01/2005	8/31/2007
Muthanna Reclamation Project	Major-010	W-R-WR-Major-205	Muthanna	The aim of the project is to raise the agricultural productivity and supply food to the farmers as well as	$28,565,000	01/01/2005	3/31/2007
Reestablish Professional & International relationships	Cap-018		Nationwide	Ministry of Water Resources employees have had very few opportunities over the past two decades t	$250,000	06/01/2005	8/31/2005
Rehabilitation of Delmage Project - Various Projects	Major-036		Wassit	Project is for irrigation and drainage lands in Wouthern Iraq. Includes lining of concrete canals, also fil	$10,000,000	01/01/2005	6/30/2005
Shamiya Barrage Rehabilitation	Barrage-002	W-R-WR-Dam-263	Najaf	The barrage crosses the Shamiyah River. Rehabilitate weir to restore safe operations, raising upstrea	$888,000	03/01/2005	5/31/2005
Tubal Dam Construction	Dam-031	W-R-WR-Dam Rural-182	Anbar	Construction of earth fill dam on Wadi Tubal in the western desert. Dam would be 490 meters in leng	$6,972,000	01/01/2005	6/30/2009
Well Drilling Equipment	Equip-008		Nationwide	The following equipment is needed: 30 well digging machines 300,000m pipes for lining wells 50 sin	$15,000,000	03/01/2005	03/01/2005
Western Gharraf Reclamation Project	Major-019	W-R-WR-Irrigation and Drainage-209	Wassit	The project includes construction of complete irrigation and dranaige networks, including structures, p	$26,646,000	01/01/2005	6/30/2005

Western Gharraf Reclamation Project – Description Field in Full

The project includes construction of complete irrigation and drainage networks, including structures, pumping stations for irrigation, drainage and earthworks. Earthworks includes land sloping and shaping to ensure proper declination. The irrigation network includes the construction of main and minor canals. Feeder canals will be lined with 5-10 centimeters of concrete, and will divide the field in to irrigation units of about 12 – 24 acres. Upstream regulators will be constructed at different canals, as well as falls, minor weirs and vehicles and pedestrians bridges. A pumping station will be constructed to raise water from the Shatt Al Gharaf to the main canals. Construction of the drainage network will include main and minor drains, collecting drains and field drains (perforated PVC). Drainage construction will also include intersecting canal structures as well as drainage pumping stations to raise the water from the main drains to the Al Gharaf big drain. • The lands of this project locate within Wassit & ThiQar governorates, and to the right side of Shatt Al Gharaf in the area between the north of Al Kut city borders ,and in the south of Al Refai˜city & to the east of Al Gharaf river &to the west of Al Gharaf big drain. • The ocurce of irrigation from Al Gharaf River which is gravity branched from Tigris River- the upstream of Al Kut barrage with drainage about 63 M3/Sec. • The drainage of the project lands goes to Al Gharaf big drain which flows into the main outfall in the north of Al Nasiriya city. Irrigation network: • It includes executing main & minor canals & also feeding canals which is lined with concrete and have the thickness of (5- 10 cm), and also dividing the field in to irrigation units of about (30-60) acres. • Executing irrigation structures including executing up stream regulators of different canals , and also control structures , and regulating distributing water between canals and it includes: cutting regulators , falls, minor weir, structures of intersecting culverts with roads, railway, oil piping (if there is any) and vehicles & pedestrians bridges. • Executing irrigation pumping stations , these stations raise water from Shatt Al Gharaf to the main canals in some above sectors with executing service structures for the stations operators. Drainage network. It includes executing main & minor drains, collecting drains, and the covered field drains by using plastic piping of (100 cm) (PVC), also executing drainage structures like drains outfalls, and also executing structures of intersecting canals with the drains and roads, and executing drainage pumping statinns to raise the water of some main drains to Al Gharaf big drain with executing service structures for the stations operators, and also developing Al Gharaf big outfall to the main outfall. Leveling works: It includes making leveling for the lands of irrigation units by raising high areas and filling low areas in a proper declination which correspond with the nature of the area.

Largest by cost	$35,000,000
Smallest by cost	$250,000

10 Recommendations

10.1 Data Sharing Arrangements

Data is fundamental to the planning process and it is essential that efforts are made to build on the improving culture of openness to data sharing that Phase 1 has strongly promoted, preferably by establishing formal protocols.

The Data Collection Leaders proved very useful to the ARDI and SWLRI staff allowing them to focus their efforts more effectively. It is recommended that the role of Data Collection Leader is retained (possibly under a new title) into Phase 2.

During Phase 1 it became apparent that there was some data that needed to be collected at governorate or district level. The mechanism for passing data requests from the SWLRI Unit to say governorate level needs to be considered. At present all requests are routed through the Data collection Leader but they may not have the authority to direct governorate staff to provide the data.

During Phase 1 the Claromentis system proved an effective route to get data transferred between ministries. This depends upon the security settings and permissions that are set by the Claromentis Administrator. It is recommended that increased access should be allowed where possible.

The situation in the upper catchments is of great interest to Iraqi planners. How to get data from the upstream neighbours as a matter of routine is something that needs to be explored. Presentations during the shorter study visit covered case studies on promoting transboundary data sharing.

10.2 Quality Control of Data

This is linked to previous section, in that QC of data should be undertaken by the home ministry not by the SWLRI unit who have neither the resources nor the experience to do this as well as it could, and should, be done by the home ministry.

In the case of GIS activities, the concept from the start has been that the MoWR should assist the other ministries to provide reliable geo-referenced data to the SWLRI unit by training them and by setting standards for QC procedures. Every opportunity was taken to reinforce this message and while it is too early to say whether the approach has been successful it seems to be the right model for the future because it should be sustainable.

10.3 Further Data to be Collected

The process of building and testing the models and analytical tools during Phase 1 has highlighted the fact that in most cases other information is still required in order to be able to complete the testing and to make full use of the Phase 1 tools in the future. Two examples have been selected to show where the lack of information available in Phase 1 has been a constraint: the use of the Iraq Multi-criterion Decision Model (Section 5.2), and the water quality model (Section 5.4).

Another particular area is the need for agricultural data records for individual irrigation schemes rather than just accumulated figures for administrative regions. This would allow the link between water supplied and actual yield of crops to be fully explored.

Appendix A Original Data Request

The Work Plan, discussed and agreed in Amman 7-9 June 2005, outlined a two phase approach with the 14 month Phase 1 concentrating on data compilation and the development of tools for use in strategic planning. This document is intended to start the process of data compilation. It provides a very long list of information that would be useful for strategic planning – not all of which may be available at this time. The list is almost certainly incomplete so comments, additions or deletions would be welcome.

Details of Information Requirements

Scene Setting

Detailed overview of infrastructure:

Maps showing all major waterways, ideally as time series eg map of systems in 1960s, 1970s, present.

Maps showing irrigated areas, on and off stream reservoirs, water supply intakes, offtakes and discharges, canal and drain systems

Surface Water Data (Rivers - canals and drains see I&D data)

(Note much of this information has already been collected by MoWR with HEC on the marshlands restoration project)

Gauging station (GS) locations (grid reference)
Date of opening and closing of GS
Method of measurement (automatic water level recorder, 3xday staff gauge, cableway etc)
Suitability of site: full range? Stable control? Bypassed during floods? etc
Indication of reliability (poor/medium/good) with justification
Daily mean discharges (m^3/s) for full period of record at each gauging station
Annual maximum instantaneous water level and discharge
All GS rating curves (current and past with dates and water level ranges for application)
All current meter measurements taken to calibrate rating curves (date of measurement, water level, discharge)
All GS channel sections (all topographic records for each site)
Water level records – required if rating curves suspect and discharges need reprocessing.
History of major river engineering works (dates, locations, consequences) including temporary and permanent diversions, provision of storage.
Details of seasonal water management practices.

Use of the data: water availability, flood and drought flows, peak flood levels, check on reliability of rating curves and therefore flow estimates, estimate of any rehabilitation/upgrading needed.

Groundwater and Spring sources

Location of monitored springs (grid reference)
Location of piezometers (grid reference)
Aquifer characteristics: stratigraphy, permeability, transmissivity, storage, hydrochemistry
Regional and subregional geological reports and maps
Hydrogeological reports and maps
Piezometer drilling records – depth, location of screen, drilling logs
Water level records from piezometers
Discharge records from springs
Borehole drilling records – depth, diameter, depth of casing, screen details, logs
Borehole locations (grid reference), pump type and characteristics, yield

Pump test records
Records of groundwater pollution
Details of groundwater pollution monitoring

Use of data: water availability, seasonal water table movement, drought water levels, estimate any rehabilitation/upgrading needed for monitoring network.

Water Quality information

Location of *routine* monitoring points for both surface and groundwaters (grid reference)
- Method of sampling and immediate treatment of samples to be taken to a laboratory
- Field test procedures
- Laboratory procedures
- Records of Parameter values eg sediment, salinity, total dissolved solids, chemical analysis etc

Location of temporary or project monitoring points (grid reference)
- Method of sampling and immediate treatment of samples to be taken to a laboratory
- Field test procedures
- Laboratory procedures
- Records of Parameter values eg sediment, salinity, total dissolved solids, chemical analysis etc

Details of laboratories carrying out water quality sampling (name, ministry or local authority name, location, range of parameters that it is equipped to test for, etc)

Reservoirs

(Note much of this information has already been collected by MoWR with HEC on the marshlands restoration project)

Date construction started, date filling completed
Design and current purpose of reservoir
Storage volume/Area/Elevation curves
Spillway details, dam height, dead storage allocation, outlet details, offtake arrangement details
Operating rules/procedures
Organisation responsible for reservoir operation
Authority responsible for providing operating rules/capacity to override rules

Regulating Structures

Date construction started and finished
Details of gates etc
Function
Capacity
Operational records
Operating rules/procedures
Current status of mechanical, electrical and civil works. Is it fully or partially operable?
Is water control achieved at present?

Data for: assessing rehabilitation/upgrading of structure, investigate operating rules

Irrigation & Drainage Systems

Irrigation system boundaries (geo-referenced)
Drainage system boundaries (geo-referenced)
Water user associations (area covered, date formed)
Reuse of drainage water
Details of water management systems (monitoring - where, how, and how often), method of communication of operational information
Number of farms overall and by size

Population directly dependent on irrigation system for majority of their income (farmers, truck drivers, local traders, support services, resident family members) – approximate population of local towns/villages is an acceptable proxy.
Design reports and feasibility studies (bibliography and location where copies obtainable (if known))

Pumping stations (fixed installations)
Location (grid reference)
Command area – design
Lift
Date construction started and finished
Energy supply
Details of installed capacity and type of pump(s)
'passport'
Current status of mechanical electrical and civil works

Small mobile pumping plant
Estimate of numbers
Capacity of typical unit
Energy supply

Regulating structures
Location (grid reference)
Date construction started and finished
Design capacity
Energy supply
Notional hydraulic characteristics
Operator's records (flow/setting)
Current status of mechanical electrical and civil works

Flood Management
Levees: location, type, nominal protection level (elevation), condition
Escapes: location of intentional breaches and escape canals
Planning regulations (zoning) and accepted return period for design (eg urban areas the target for defence works could be from all floods up to 100 year flood)
Current forecasting and warning practice
Historical flooded areas (focus on Baghdad and other population centres)
Records of damage caused by flooding (monetary value and year)

Policies: Past, Current, and under development by sector
Trade (including import/export)
Agriculture
Melioration
Water supply and sanitation
Water charges
Licensing of abstractions for surface or groundwater
Water user associations
Environment – water quality, wildlife, sustainability
Energy especially policies on role of hydropower
Transport especially policies on role of inland waterways
Industry
Institutional structures – roles of ministries, state organisations, local government, private companies/organisations

Legal Agreements, Treaty obligations
International basins
Transboundary water related agreements eg Shatt al Arab
Environmental standards (including water quality)
Bibliography of all current legislation affecting water and the water-related environment

Public Water Supply and Sewage Disposal
Demography and spatial distribution of population
Socio-economic data (income levels)
Numbers of houses with full piped water/flush toilets
Numbers of houses with septic tank
Demand forecasts
Urban and rural population (past and forecast)
% population with access to treated drinking water
% population served by distribution systems
% of distribution system requiring rehabilitation
% population served by sewage systems
% of sewerage system requiring rehabilitation
location of potable water treatment works (grid reference)
type of water treatment at each works
Each works: abstraction from what? and where is intake or borehole (grid reference)
Water quality at intake and after treatment (range of values)
Water quality problem areas and their extent
location of sewage treatment works (grid reference)
type of sewage treatment at each works
Each works: discharge to what? and where is outlet (grid reference)
water quality of effluent (range of values)

Industrial Water Use and Discharges
Estimate of usage provided through public water supply systems
Demand forecasts
location of industrial user (grid reference)
type of industry and nature of use of water
Discharge to what? And where is outlet (grid reference)
water quality of effluent (range of values)
Details of any on-site effluent treatment
Water quality problem areas and their extent

Industrial Water Use and Discharges
Estimate of usage not provided through public water supply systems
Demand forecasts
location of industrial user (grid reference)
type of industry and nature of use of water
Each intake: abstraction from what source? and where is intake or borehole (grid reference)
Water quality at intake (range of values)
discharge to what? And where is outlet (grid reference)
water quality of effluent (range of values)
Water quality problem areas and their extent

Land/Agriculture
Land use (current and trends)
Irrigated lands
Cropped area by crop type and district

Crop water requirements including land preparation/leaching needs
Agricultural production statistics by district and by crop
Constraints to land development options eg maps showing steep slopes, areas subject to serious soil erosion, areas subject to salinisation, areas subject to seasonal flooding
Details of any studies on constraints (bibliography)
Land condition: salinity level, depth to water table, quality of shallow groundwater
Agricultural drainage: presence/absence, type of system, conditions (functioning/ barely functioning/not functioning)
Livestock numbers estimates by district and type (current and trends)
Details of agri-processing plant (eg sugar refinery location, capacity, current production level)

Energy Sector
National generation capacity kWhr by year and maximum load kW
Annual pattern of load
Daily pattern of load (winter and summer separately)
List of power stations by region with installed capacity and type
Projections of future power demand
Transmission system description

Hydropower Installations
Location
Installed capacity and when installed
Type of turbines, turbine characteristics
Is it a multipurpose reservoir/barrage? If so what is the priority of the needs of power generation compared to the other uses?
Operating rules
Operating records (discharges, power generated eg monthly)

Channel Morphology
Known problem areas for erosion/deposition
Navigation routes and target depths
Number/capacity of dredgers
Annual volume of dredging by river reach
Annual cost of dredging
Cross sections with date of survey

Navigation
Location and physical characteristics of locks
Location of ports/docks
Locking arrangements
Estimates of traffic (past and current)
Value of cargo transported
Operation costs (boat running costs, cost of maintaining locks, wharves etc)
Forecast traffic and cargo
Estimated volume of cargo transported by land
Proportion of annual cargo transported carried by water
List constraints to navigation and proposed measures

GIS (geo-referenced in accordance with coordinate system to be used throughout the project)
Satellite imagery for base mapping
Rivers/lakes geo-referenced
Administrative boundaries
Hydrologic and hydrogeologic sub-basin boundaries

Meteorological Information
Location of synoptic, agrometeorological and rainfall stations
Periods of record
Indication of reliability
Parameter values: temperature, humidity, wind, sunshine, evaporation

Economic Aspects
Tariff for power
Water charging structures
Cost information for engineering works to build up cost estimates for potential development or rehabilitation packages
Agricultural prices (inputs and outputs), subsidies.
Taxes and duties affecting water users (municipal, rural, industrial)
State guaranteed price arrangements

Environment
Boundaries of any designated nature reserves, Ramsar sites etc
Details of studies eg Marsh Restoration
Red data species or habitats
Shatt al Arab and obligations to Gulf water quality

Upstream Countries
(such information as can be obtained from published sources or informal contacts)
Planned developments on rivers draining to Iraq
Policies for development in water sector
Studies on developments
Studies on environmental impact of planned developments

Institutional Structures
Government organisation structures as affects water/agriculture/environment sector
Details of rights enjoyed by Government national and local and its agents to act in these sectors
Chain of command and reporting for operation of water related infrastructure
Chain of command and reporting for monitoring of water resources and their use ie where is monitoring data processed and where is it stored (locally/centrally etc)

References/Studies etc
Updating of the preliminary list of relevant papers, studies etc circulated at the Amman meeting on completed or ongoing projects
Schedule of proposed project support eg plans of various UN agencies described by the UNESCO representative at the Amman meeting.

Appendix B Record of Discussions with the Groundwater Studies Centre

Record of Meeting/Discussion

Project Title	Strategy for Water and Land Resources in Iraq	**Division**	WER
Subject	Groundwater Studies Centre	**Project No.**	208465
Location	Teleconference – Cambridge - Baghdad	**Date of Meeting**	16/06/06
Present	Dr Sadik (DS), Groundwater Studies Centre	ARDI:	
		Milo Simonic	
		Charles Jones	
		Cat Watts	
		Clare Wilson	

Recorded by	**Distribution**
CHW	Present, plus Alison Stuck, Neil Morris, Peter Halifax, Andrew Paskins, John Prytherch, Phil le Gouais

Item	**Text**	**Action on**
1 0	Introductions	
1 1	Introduction to the Groundwater Studies Centre • Established 2 years ago • Part of the Ministry of Water Resources • Role: improving data collection and water resources management	
1 2	4 specific projects being undertaken at present: 1. Collection of data • Information is being collected on wells, geology, hydrological data • A database is being established • Producing maps on scale of 1: 1 million *ARDI would like to know more about the database that is being set up and the maps that are available.*	DS
	2. Nationwide Monitoring Network • At present there is no countrywide monitoring network in place • Monitoring has been undertaken on a short term basis for specific projects (e.g. the FAO work). Some existing monitoring is being continued? • A new monitoring network is currently being designed • The first year of this work has comprised the delineation of the aquifers, their condition, and fluctuations in water level – this will determine the monitoring network that will be designed • 15 aquifers have been delineated, of which five or six are the main ones. • The delineation has been completed for the desert (formation and thickness) and has been started in other areas. • The focus has been to start on areas where aquifers are already exploited, and then extend the work. • Maps have been produced • Approximately 300 monitoring wells will be established.	

Record of Meeting/Discussion Continuation Sheet

Project No. 208465 **Date of Meeting** 16/06/06

Item		Text	Action on
		• Work is being funded by Ministry of Water Resources *ARDI will review the monitoring data we have already, and then contact Dr Sadik regarding gaps* *We would like to see the maps of the desert, and aquifers that have been delineated* 3. Eco-Agricultural Zoning • Maps being produced that relate to the susceptibility of groundwater and its suitability for agriculture • Presentation made to SWRLI steering group meeting about this project • 40 areas identified as suitable (?) • Iraq divided into five regions, three of which defined as suitable (?) • Study plans are being defined for selected areas. • Survey undertaken on 1:250 000 scale. • Certain areas in the north not covered yet, but these have been examined in the FAO report. 4th project?	
2	0	Outputs • No reports produced yet for the projects listed above • However, some proposals have been sent to funding agencies, but have not yet been successful in obtaining funding. • E.g. proposal for Diyala Basin – to try to get groundwater used as a resource • Comment – more use of groundwater in the north will save surface water in the south and improve water quality.	
3	0	ARDI outputs • Dr Sadik suggested Diyala and Lower Zab basin as appropriate pilot areas that he is already working on (note – river basin areas, not governorates)	MM to include at least one of these areas as a pilot
4	0	GIS data • There is a GIS centre in the Directorate, but the Groundwater Studies Centre staff need training – they have put forward a proposal for future capacity building. • GIS was used as a tool in the agriculture work – AEZ mapping. • Some training has already been undertaken.	
5	0	Groundwater Studies Centre staffing • 12 people • Many have long experience • Mainly hydrogeologists and geophysisists	
6	0	Groundwater modelling • Three or four people in Centre trained in modelling	

Record of Meeting/Discussion Continuation Sheet

Project No. 208465 **Date of Meeting** 16/06/06

Item		Text	Action on
		• There is a 2-d 1982 groundwater model of Erbil (Dr Sadik involved) • In 2005 they agreed to construct a new model of Erbil, but there is a present lack of resources • Dr Sadik knew of approximately ten groundwater models that had been developed.	
7	0	Estimating recharge • They do some water balance calculations to estimate recharge, and then check them, e.g by using isotope data for Kerbala. • Keen for ARDI to provide advice in recharge estimation	
8	0	Well drilling • Noted that the drilling of abstraction wells is not covered by the Groundwater Studies Centre, and they do not hold information on what wells are in existence	
9	0	Irrigation return water • No studies undertaken by Groundwater Studies Centre, but some work may have been done by the College of Engineering.	
10	0	Claromentis – SWRLI extranet • ARDI to investigate obtaining access to Claromentis for Dr Sadik	

